A NOVEL APPROACH TO MEASURING INELASTIC DIFFERENTIAL CROSS SECTIONS FOR ELECTRON-MOLECULE COLLISIONS

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The absolute measurement of inelastic differential cross sections (DCS's) for electrons scattering from atoms and molecules presents a problem especially at low residual energy. It usually requires a precise knowledge of the instrument response function (IRF) and the scattering geometry, which are difficult to obtain at best. Electron beam properties and the IRF are sensitive to surface conditions, electric and magnetic fields, etc. Even when it is possible to get that information, it is susceptible to drift which can occur during the long times mm-wary to acquire data.

Presently, the most commonly accepted calibration procedure goes as follows. Measure relative scattering intensities associated with various channels. Then, apply some corrections to these intensities based on some relative IRF. Finally, calibration to the absolute scale is achieved by using a known absolute cross section as a standard. The difficulty in this procedure is to establish a condition under which the dependence of the IRF on the residual energy of the scattered electrons is known. Moreover, the IRF at one impact energy must be related to another impact energy. So far, no rigorous method for overcoming this difficulty is available in practice. A recent discussion of these matters has been given by Trajmar and McConkey[1].

We are presently investigating a new approach to this problem. In this new approach the conventionally used hemispherical (or cylindrical) electron energy analyzer (detector) is replaced with a specially constructed field free drift tube. The tube is terminated with a 40 mm diameter multi-channel plate configured to detect electrons. Time-of-flight (TOF) spectra of electrons scattered from the target molecule are obtained (at fixed impact energies and scattering angles) by pulsing the incident electron beam. The incident beam is produced by an unselected electron gun with an energy distribution of approximately 0.4 CV.

The inelastic to elastic scattering intensity ratios obtained from the TOF spectra represent the corresponding DCS ratios. Under proper conditions, these intensity ratios should be independent of residual energy, impact energy, and the scattering geometry. From well established elastic DCS's

one then obtains inelastic DCS's. These can serve as secondary standards for normalizing relative inelastic DCS's obtained with conventional electron energy analyzers in crossed beam experiments over some ranges of energy loss.

Our preliminary results with CO and He are promising. A sample TOF spectrum from CO (Figure 1) shows the elastic scattering (-133 ns) and $a^3\Pi$ state excitation (200-300 ns) features. The vibrational levels cannot be resolved with our present setup. From figure 1, the intensity ratio of the $a^3\Pi$ feature to the elastic peak is 0.18 ± 0.02, which is in good agreement with the recent measurements of Zobel et al.[2]
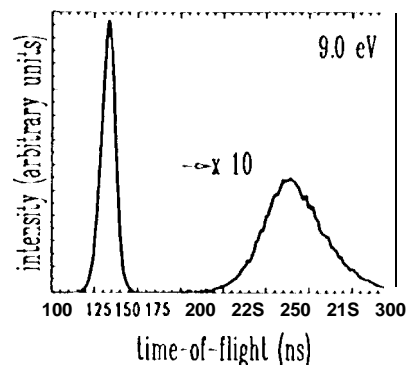

Figure 1 TOF spectrum of 9.0 eV electrons scattered from CO at 90". Note the factor of 10 magnification applied to the data over 175 ns.

References

1. S. Trajmar and J. W. McConkey in *Advances in Atomic, Molecular, and Optical Physics, in* press.
2. J. Zobel, U. Mayer, K, Jung, D.N. Tripathi, D.K. Rai and H. Erhardt, (1 9 9 5), *private communication, to be published.*